

2021

Company services Testing Facilities



POWERLABS

**Engineering services for e-Mobility
solutions**



Index

1

EPowerlabs: team and background

2

Powertrain Test Cell

3

Power Electronics Test Cell

4

Battery Testing Equipment



EPowerlabs offers engineering and product development services to help clients develop E-mobility applications swiftly

1

Our value proposal

- **Experience in power electronics development is scarce in the market** and a barrier for many players
- Long term expertise in testing procedures of powertrains and its components, DVP's & RCA
- Our main value helps to **accelerate the product development and validation processes**
- We are located in San Sebastian (Spain), at the "Miramón" technological centre, place of several leading industrial companies in Spain



Team Background

- **Extensive international experience** working on different companies and countries
- The team members have developed their professional careers in **top leading international** companies; OEM & Tier 1
- EPL's team members are involved on the e-Mobility branch for nearly 10 years **developing and validating powertrain solutions**



Target industries

- The business is focused on those industries in which the **electrification trend** is already a **game changer** in mobility solutions



Automotive



Motorcycles



Heavy Duty



Off – Road / Material Handling



Marine



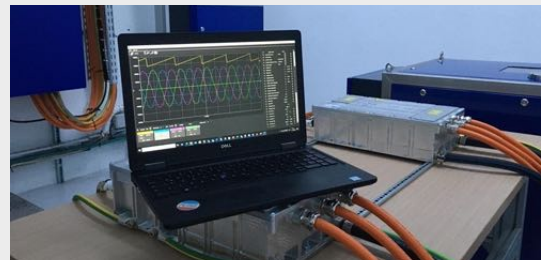
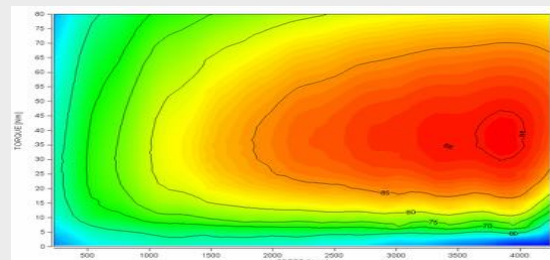
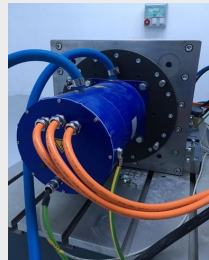
Powertrain testing Cell

1

2

3

4



Powertrain

Testing Capabilities

Epowlabs operates state of the art test benches for electromobility at MUBIL Technology Center, providing our long-term expertise and innovative strength of the automotive branch.

Wide range of testing capabilities e.g.:

- Performance testing
 - Power curves
 - Efficiency Mapping
 - Flux Mapping
 - MTPA
 - BEMF
 - Drag losses
 - No Load & Locked rotor
- Endurance testing
 - Heat Cycle
 - High Temperature Cycle
 - Humidity Cycle
- HiL testing

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system



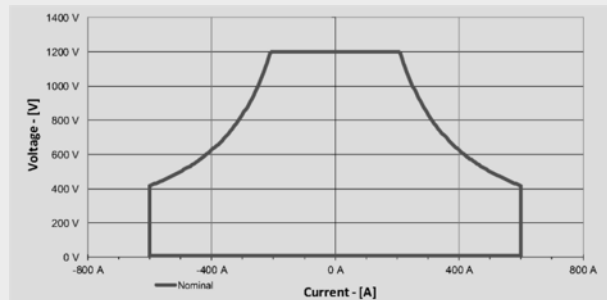
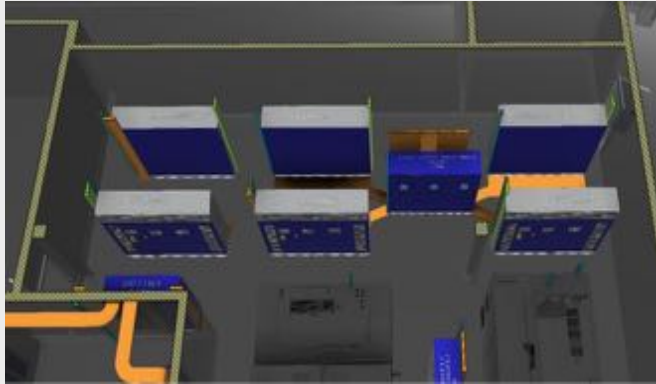
Powertrain testing Cell – Battery Simulator

1

2

3

4



Technical specifications

Battery Simulator

- Max. Output Power: 250kW
- Max. Output Voltage: 1200V
- Max. Current: $\pm 600\text{A}$
- Max. Current gradient: 1000A/ms
- Control modes:
 - Voltage regulation
 - Current control
 - Power control
- Virtual internal resistance setting (-2Ω to $+2\Omega$)
- Power Distribution Unit (PDU) is capable to allocate two different voltage sources, e.g., a customers battery pack for being tested.
- 5 Battery Simulators available, each of them of 250kW.
- Up to 4 Battery Simulators can be used in parallel mode $\rightarrow 1\text{MW}$
- 6th Battery Simulator planned for Q4 2021

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system



Powertrain testing Cell – Dyno & Inverter

1

2

3

4

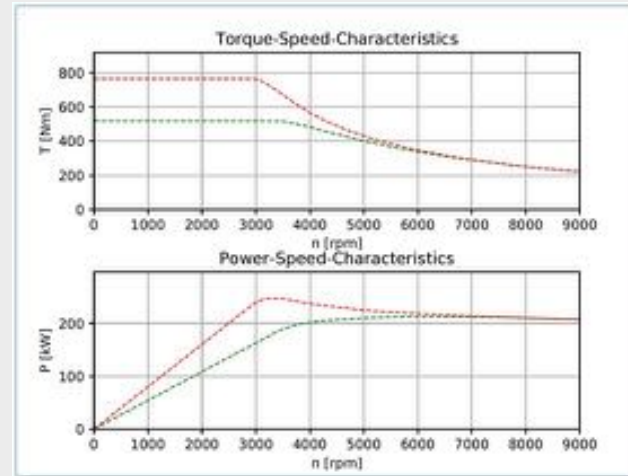
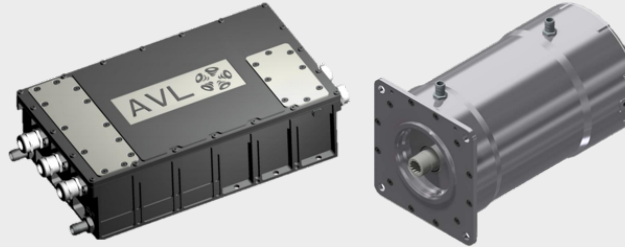
Technical specifications

Power Traction Inverters

- Nominal Power: 190kW
- Peak Power: 260kW
- Vdc supply range: 200V → 800V
- Nominal current: 300Arms
- Peak current; 490Arms → 6s
- Switching Frequency range: 2kHz → 10kHz
- LV Supply range: 9,9V → 16V

Capabilities

- Max. electric rotation frequency, e.g., ground wave, is 1kHz.
- Freewheeling possibility for BEMF tests.
- Active Short Circuit can be activated by software.
- SinCos RLS can be read.
- Excitation signal for RLS, Vout: 3,2V → 4V
- Two inverters are available for customers, highly valued and cost effective for EM developers.



Technical specifications

Dyno Motor – RAMME HO245

- Continuous Power: 190kW
- Continuous Torque: 520Nm
- Speed range: 0rpm → 9000rpm
- Nominal Phase current: 300Arms
- Peak Power: 241kW
- Peak Torque: 762Nm
- Peak Phase current: 470Arms
- Increases flexibility for testing only an inverter if the customer has no EM.
- 2 units are available

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system



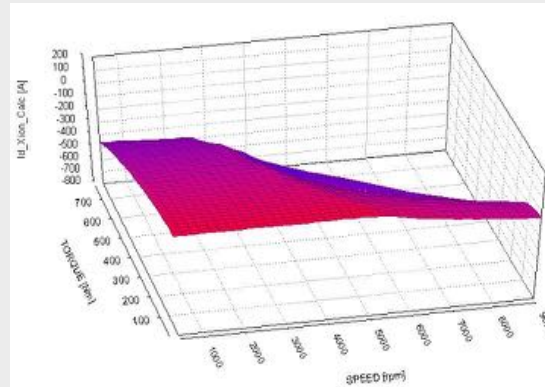
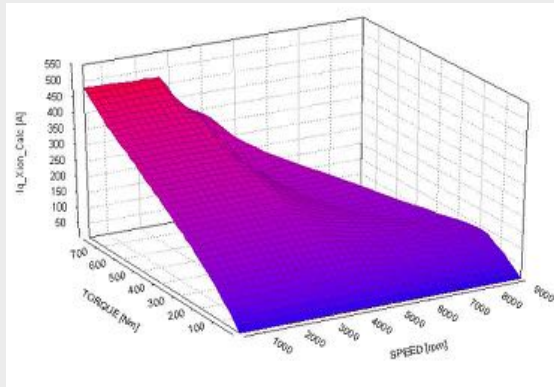
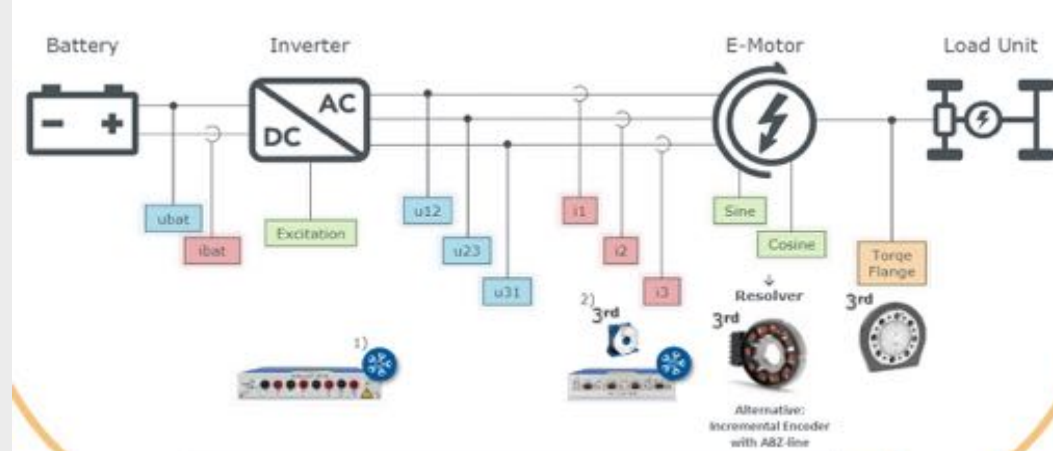
Powertrain testing Cell – Power Measurement System X-Ion

1

2

3

4



Technical specifications

Input Range

- 4 Channels Differential Input: $\pm 1500V$
- 4 Channels $\pm 1000A$
- 1 Channel Torque Measurement: Up to 2kN
- 1 Channel RLS position

Torque Transducer

- HBM T40B: 2kN & 15krpm
- Other torque ranges available under request

Accuracy

- Voltage: 0.015% Reading + 0.02% Range
- Current: 0.005% Reading + 0.03% Range
- Torque: Accuracy class 0.05%

Capabilities of X-Ion & Indicom

- Real Time Calculations of Power & Efficiency
- Possibility of Adding Custom Calculations
- Up to 2MHz of Sampling Rate

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system



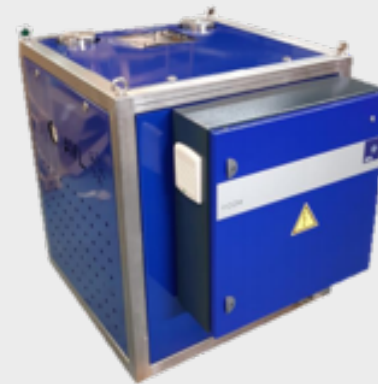
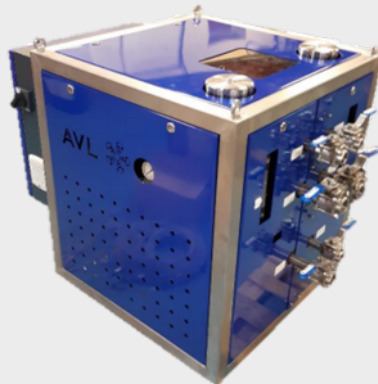
Powertrain testing Cell – Coolant & Oil Conditioners

1

2

3

4



Technical specifications

Water-Glycol Conditioner

- Flow rate: up to 16l/min
- Max. Heat dissipation: 14kW
- Water – Glycol mixture up to 50%-50%
- Temperature range: 10°C → 65°C

Oil Conditioner

- Flow rate: up to 26l/min
- Max. Heat dissipation: 14kW
- Wide range of admissible oil types
- Temperature range: 10°C → 100°C

Availability

- 2 units for glycol fluid conditioner
- 2 units for oil liquid conditioner

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system



Powertrain testing Cell – DAQ's

1

2

3

4



Technical specifications

Data Acquisition System

- x4 CAN/CAN-FD Channels
- x1 FEM-DCC Module:
 - 8 Analog Outputs 16-bit
 - 16 Digital Outputs
 - 16 Digital Inputs
 - 8 Incremental counter up to 500kHz
- x2 FEM-AIS Module (Analog Inputs):
 - 16 Universal input channels per Module → 32 Channels in total
 - Each channel can be used, configured and calibrated for:
 - Voltage source → $\pm 75\text{mV}$, $\pm 2.4\text{V}$, $\pm 13.5\text{V}$
 - Current source → $\pm 25\text{mA}$
 - Thermocouples with wide range of types
 - PT100 or PT1000
 - Strain Gage
- x2 FEM-DIO (Digital Inputs & Outputs):
 - 16 Digital Inputs → 32 in total
 - 16 Digital Outputs → 32 in total

Full automated Powertrain testbed with AVL PUMA2 automation and measurement system



Power electronics testing Cell

1

2

3

4

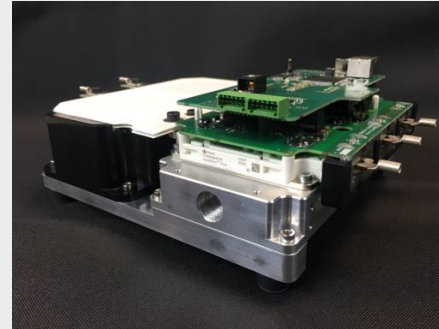
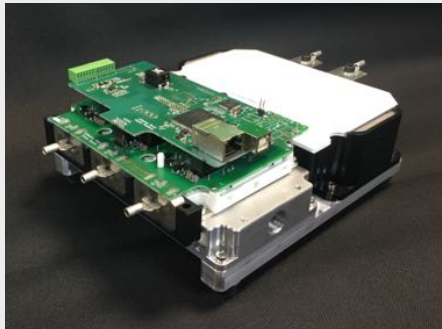


Power Electronics

Testing Capabilities

Epowlabs offers end to end engineering services independently, or supported by technological partners, offering complete DVP&R and RCA for the overall e-mobility components such as Inverters, DC/DC, BMS, eDrives, xCU's and others.

In the Power Electronics field to help the upcoming challenges of WBG semiconductors converters in their development and test, a full measurement equipment with high precision voltage and current probes and posterior signal conditioning are among EPowerlabs testing capabilities.



Full automated Power Electronics testbed with AVL PUMA2 automation and measurement system



Power electronics testing Cell – Grid emulator & Electronic Loads

1

2

3

4

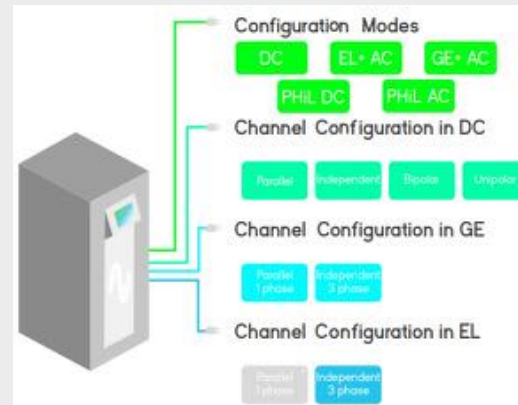
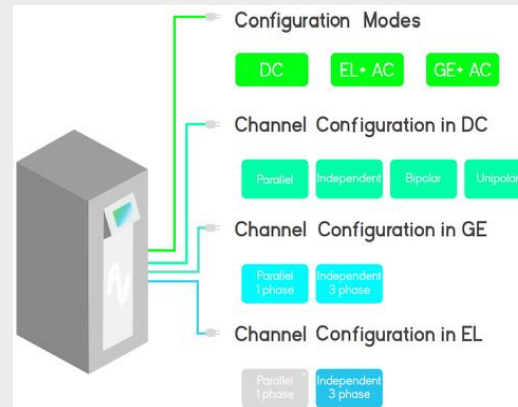
Grid emulator & Electronic Load (AC & DC)

Cinergia GEL AC&DC + HV

- Rated Power: 50kVA
- Rated Phase Current: 73A
- Rated Current: 219A
- Voltage Range: 0V → 800V
- THDi < 3%

Capabilities

- Complete DC Load & Source
- 4Q AC Grid Emulator
- Power amplifier for Power HiL
- 4Q AC Electronic Load
- Battery Emulation and Testing
- PV Panel Emulation



Grid emulator & Electronic Load (AC)

Cinergia GEL AC + HV

- Rated Power: 50kVA
- Rated Phase Current: 73A
- Rated Current: 219A
- Voltage Range: 0V → 400V
- THDi < 3%

Capabilities

- 4Q AC Grid Emulator
- Power amplifier for Power HiL
- 4Q AC Electronic Load
- Disturbance Generation
- Harmonics Control

Full automated Power Electronics testbed with AVL PUMA2 automation and measurement system



Power electronics testing Cell – e.g. Inverter & DC-DC tests

1

2

3

4

Inverter testing

Inverter testing capabilities

■ Calibration tests:

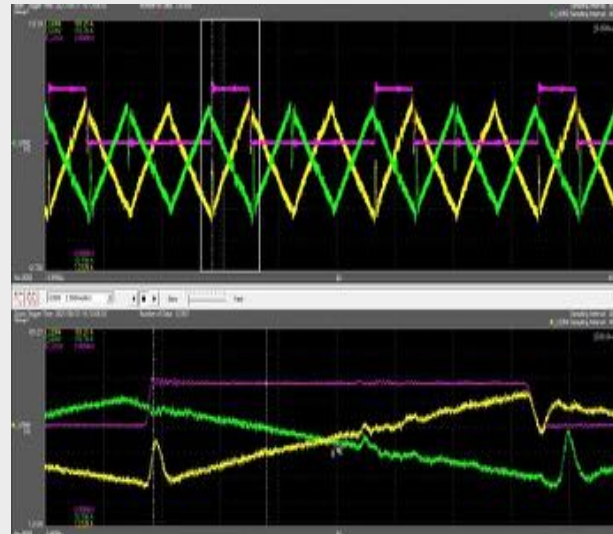
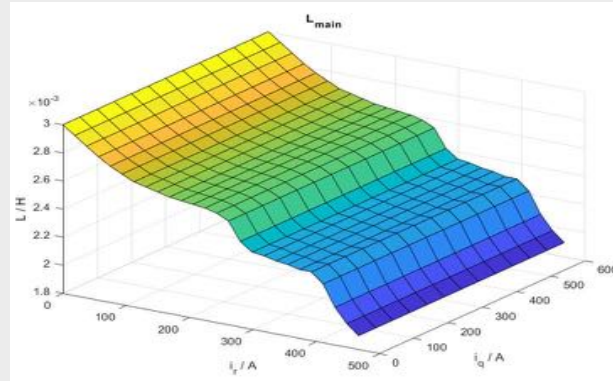
- Current Maps fine tuning
- Rotor Temperature Estimation
- RLS fine tuning
- Autocalibration routine verification
- Low Power Current Control testing
- Low Power Speed Control testing
- Voltage & Current Sensing calibration
- Input Voltage Derating measurement
- Interlock time & Switching definition
- Position estimator check

■ Performance tests:

- Efficiency map
- Peak Current measurement
- Active Short Circuit test
- Dead Time Compensation Test

■ Verification tests:

- Harmonics Robustness Test
- Interlock Time & Switching Definition
- Current & Voltage Ripple analysis



DC-DC testing

DC-DC testing capabilities

■ System Tests

- Mid & Full Power Current Control testing
- Voltage, Current & Temperature Calibration
- Full Power Voltage Control Testing

■ Verification Tests

- Efficiency measurement
- Peak Current measurement
- Line regulation Accuracy & Transients
- Load regulation Accuracy
- Slew Rate and Step response
- Output Voltage regulation accuracy
- Current & Voltage ripple measurement
- Input & Output Voltage Derating
- Temperature Derating

Full automated Power Electronics testbed with AVL PUMA2 automation and measurement system



Battery testing equipment: Walk – In Chambers

1

2

3

4



Technical specifications

Weiss Technik Walk-In Chambers (30m³) & (18m³)

- Hazard Level 6 safety Level
- Temperature range from -60°C to +100°C
- Humidity range: 10% to 95% r.H (10°C → 70°C)
- Cooling gradient 2°C/min
- Heating gradient 2°C/min

HV Power Supply Battery Pack Cyclers – Up to 1MW

- Configuration modes:
 - 4 Channels → 1200V – 600A – 250kW
 - 1 Channel → 1200V – 1200A – 500kW
 - 2 Channels → 1200V – 600A – 250kW
 - 2 Channels → 1200V – 1200A – 500kW
 - 1 Channel → 1200V – 2400A – 1MW

Weiss Technik Walk In Chambers controlled by AVL LYNX automation & measurement system



Battery testing equipment: Cell & Module Cyclers

1

2

3

4



Technical specifications

Chroma 17020 – Battery Cell Cyclers

- Max. Current (Parallelable) → 1200A
- Max. Power (Parallelable) → 60kW
- Voltage range → 0V to 100V
- Current → 50A per channel
- Power → 2.5kW per channel
- Channels → 64 Channels available in total
- Test rigs → 3

Chroma 17011 – Battery Cell Cyclers

- Voltage → 1.5V to 6V
 - Channels → 420 Channels available in total
 - Test rigs → 13
-
- All Battery Cell Cyclers are equipped with climatic chambers from Weiss Technik and CTS, including the availability of an **Altitude Chamber** from Weiss Technik model Sky Event 500TAH.

Cell & Modules testing laboratory view



Battery testing equipment: Cell & Module Climatic Cyclers

1

2

3

4

5



Technical specifications

CTS CS-40/1000 Climatic Chamber

- Hazard Level 4 safety level
- Temperature range from -40°C to $+180^{\circ}\text{C}$
- Humidity range from 10% to 98% relative humidity ($+10^{\circ}\text{C}$ to $+95^{\circ}\text{C}$)
- Cooling gradient $5^{\circ}\text{C}/\text{min}$
- Heating gradient $6^{\circ}\text{C}/\text{min}$
- 3 units available

Weiss TempEvent T/1000 Climatic Chamber

- Hazard Level 4 safety level
- Temperature range from -42°C to $+180^{\circ}\text{C}$
- Cooling gradient $3.1^{\circ}\text{C}/\text{min}$
- Heating gradient $4.1^{\circ}\text{C}/\text{min}$
- 5 units available

Cell & Modules testing laboratory view



Shaker testing equipment: Dual Shaker Test bench

1

2

3

4



Technical specifications

Dual Shaker IMV

- Frequency Range 5-2500Hz
- Rated Sine Force 40kN
- Rated Shock Force 80kN
- Maximum Sine Acc. 1142m/s^2
- Maximum Shock Acc. 2284m/s^2
- Max Velocity of Sine force $2,4\text{m/s}$
- Max. velocity of Shock force $4,6\text{m/s}$
- Max. Sine displacement: 51mmp-p
- Maximum Disp. Maximum Travel: 68mmp-p

The shaker testbench is formed by 2 shakers of 40kN each operating between 5-2500Hz. They can work in dual mode phase synchronized in real time. One of the shakers can be moved, so the dimensions can be adjusted to the DUT's geometry.

Synchronized Dual-Shaker test rig